Empirical study of the solar wind momentum balance in the ecliptic plane between 0.3 and 1 AU

J. J. Podesta

NASA Goddard Space Flight Center
Laboratory for Solar and Space Physics

Over length and time scales much greater than the characteristic microscales of the plasma, the macroscopic dynamics of the solar wind are adequately described using the equations of ideal magnetohydrodynamics (MHD). The dynamic effects of macroscopic fluctuations and turbulence, including the Alfvén wave pressure, may be taken into account by using the Reynolds' averaged equations of motion and compressibility effects may also be included by using the standard technique of mass averaging. In this study, the different terms in the ensemble averaged equations of motion are evaluated by fitting radial bin averages computed from Helios data to radial power laws. The effects of compressibility are fully included by using the technique of mass averaging where appropriate. Using empirical fits obtained from the Helios data, the solar wind acceleration and the forces responsible for driving that acceleration are evaluated. The measurement of the acceleration between 0.3 and 1 AU is difficult because of its small magnitude and the existence of relatively large velocity variations. Using the 15 year data record from the Pioneer Venus Orbiter combined with overlapping data from the OMNI database at 1 AU, an independent estimate of the solar wind acceleration at 0.86 AU yields the value 0.123 m/s^2. The Pioneer-Venus results support the empirical results derived from the Helios measurements. Empirical tests of the radial momentum balance in the solar wind are presented although the large error bars make it difficult to obtain precise results.